2. Wiring materials and methods

Materials for wiring interior electrical systems in buildings vary depending on:

- Intended use and amount of power demand on the circuit
- Type of occupancy and size of the building
- National and local regulations
- Environment in which the wiring must operate.

Wiring systems in a single family home or flat, for example, are simple, with relatively low power requirements.

In a light commercial environment , large apparatus may be installed, and special conditions of heat or moisture may apply.

Heavy industries have more demanding wiring requirements, such as very large currents and higher voltages.

In facilities that handle flammable gases or liquids, special rules may govern the installation and wiring of electrical equipment in hazardous areas.

Wires and cables

Wires and cables are the main part of electrical installation. The rated by the circuit voltage, temperature rating, and environmental conditions in which they can be used.

A wire or cable has a voltage (to neutral) rating, and a maximum conductor surface temperature rating. The amount of current a cable or wire can safely carry depends on the installation conditions.

Early wires and cables

- **PI** : Paper-insulated cable is introduced in the United Kingdom in 1896, consisted of two impregnated-paper-insulated conductors in an overall lead sheath. These cables were similar to underground

telegraph and telephone cables of the time. Paper-insulated cables proved unsuitable for interior wiring installations because very careful workmanship was required on the lead sheaths to ensure moisture did not affect the insulation.

- **VIR** : In 1908 vulcanized-rubber insulated wire (**VIR**) enclosed in a strip metal sheath. The metal sheath was bonded to each metal wiring device to ensure earthing continuity.
- **TRS** : In the 1930 s' Tough rubber insulated or sheathed wire (**TRS**) were used for most electrical installation for buildings. Over time, rubber-insulated wires and cables become brittle because of exposure to atmospheric oxygen, so they must be handled with care, and are usually replaced during renovations . Hence Rubber insulation is no longer used for permanent wiring installations, but may still be used for replaceable temporary cables where flexibility is important, such as electrical extension cords.
- **PVC** : About 1950, **PVC** (poly vinyl chloride) insulation and jackets were introduced, especially for residential wiring. About the same time, single conductors with a thinner **PVC** insulation and a thin nylon jacket became common. The simplest form of cable has two insulated conductors twisted together to form a unit; such unjacketed cables with two or three conductors are used for low-voltage signal and control applications, see Fig.1.

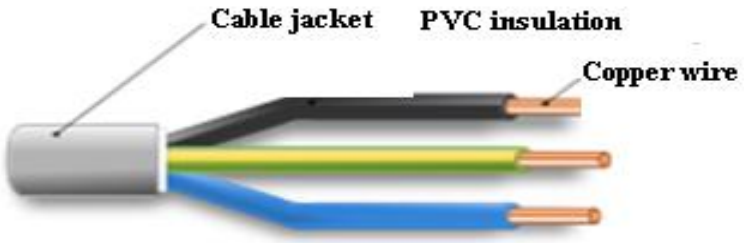


Fig.1 PVC insulated wire or cable with three pvc insulated conductors.

Copper conductors : *Copper wire and cable*

Electrical devices often contain copper conductors because of their multiple beneficial properties, including:

- high electrical conductivity,

- high tensile strength,
- high ductility,
- corrosion resistance,
- good thermal conductivity,
- solderability,
- resistance to electrical overloads,
- compatibility with electrical insulators, and
- ease of installation.

Despite competition from other materials, copper remains the preferred electrical conductor in nearly all categories of electrical wiring.

Aluminium conductors: *Aluminium wires and cables*

Aluminium wire was common in some countries residential wiring from the late 1960s to mid-1970s due to the rising cost of copper. Because of its greater resistivity, aluminium wiring requires larger conductors than copper.

Aluminium conductors were originally used with wiring devices intended for copper conductors. This practice was found to cause defective connections unless the aluminium was one of a special alloy, or all devices — breakers, switches, receptacles, splice connectors, wire nuts, etc. were specially designed for the purpose.

Aluminium conductors are still used for bulk power distribution and large feeder circuits, because they cost less than copper wiring, and weigh less, especially in the large sizes needed for heavy current loads. Aluminium conductors must be installed with compatible connectors.

Modern wiring materials

- Modern non-metallic sheathed cables, such as Types pvc / pvc and NYY (Germen) cables, consist of two to four wires covered with thermoplastic insulation, plus a bare wire for grounding (bonding), surrounded by a flexible plastic jacket.
- Special versions of non-metallic sheathed cables, such as Type pvc insulated pvc sheathed, are designed for direct underground burial (often with separate mechanical protection) or exterior use where exposure to ultraviolet radiation (UV) is a possibility. These

cables differ in having a moisture-resistant construction, lacking paper or other absorbent fillers, and being formulated for UV resistance.

- Rubber-like synthetic polymer insulation is used in industrial cables and power cables installed underground because of its superior moisture resistance.
- Generally, single conductor building wire in small sizes is solid wire, since the wiring is not required to be very flexible. Building wire conductors larger than 6 mm² (10 AWG) are stranded for flexibility during installation, but are not sufficiently pliable to use as appliance cord.
- Cables for industrial, commercial, and apartment buildings may contain many insulated conductors in an overall jacket, with helical tape steel or aluminium armour **AWA**, or steel wire armour **SWA**, and perhaps as well an overall PVC or lead jacket for protection from moisture and physical damage.
- Another form of high-temperature cable is a mineral insulated cable **MICC**, with individual conductors placed within a copper tube, and the space filled with magnesium oxide powder. The whole assembly is drawn down to smaller sizes, thereby compressing the powder. Such cables have a certified fire resistance rating, and are more costly than non-fire rated cable. They have little flexibility and behave more like rigid conduit rather than flexible cables.

Raceways or electrical conduits

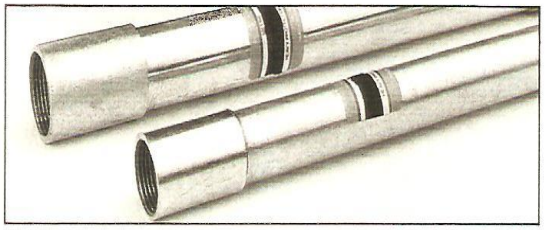
Electrical Conduit and Raceways are used to protect cables from damage. Insulated wires may be run in one of several forms of a raceway between electrical devices. This may be a specialized bendable pipe, called a conduit .

Types of condut

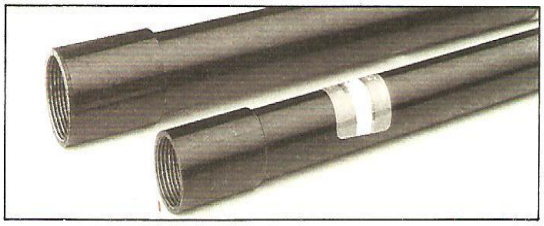
!. Metal conduit (rigid galvanized steel or Black Enameled Steel conduit),see Fig.1.

2. Non-metallic (PVC or HDPE) tubing (piping), see Fig.2.

3. Rectangular cross-section metal or PVC wire or trunking (UK) may be used if many circuits are required, see Fig.3.



Galvanized steel Conduit



Black Enameled Steel conduit

Fig.1 Metal conduit

Fig.2 Non-metallic (PVC or HDPE) pipes

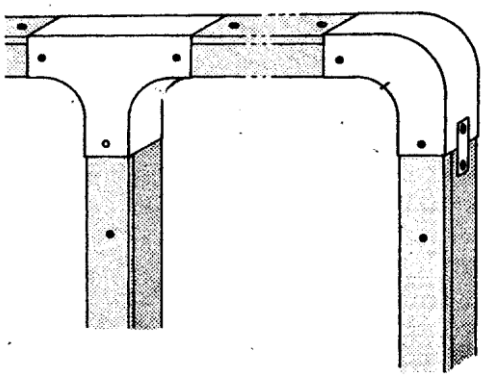
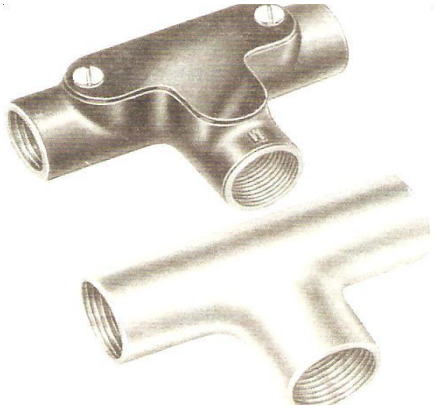


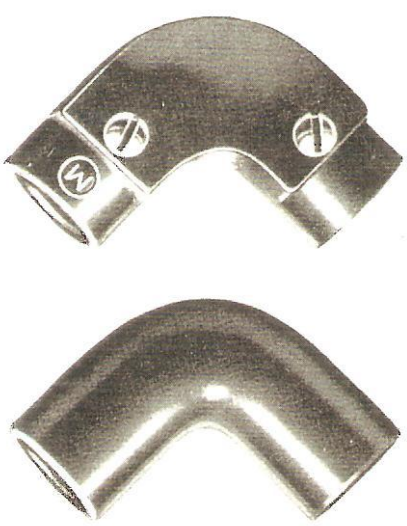
Fig.3 Rectangular cross-section metal or PVC wire or **trunking**.

Wires run underground may be run in plastic tubing encased in concrete, but metal elbows may be used in severe pulls.

Conduit accessories: Metal conduit accessories are:



TEES

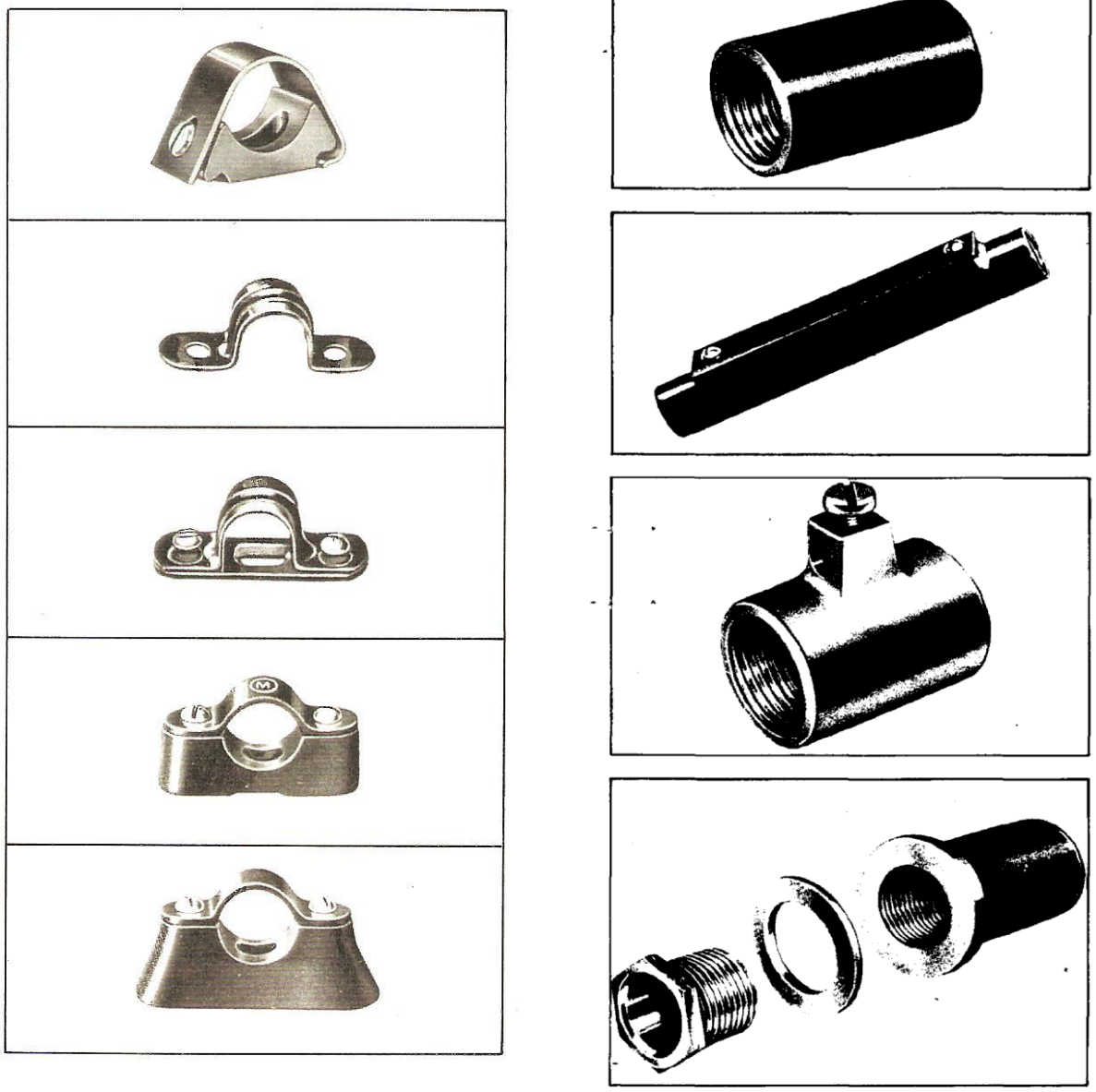


ELBOWS & BENDS

HOOK

BOXES

Fig.4 Conduit accessories.



SADDLES CNNECTORS

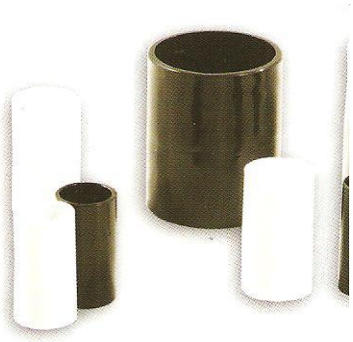
Fig.5 Conduit accessories.

PVC Pipes accessories

JUNCTIONS

ELBOWS

ADDAPTERS



CONNECTORS

BOXES

SADDLES

Fig.6 PVC accessories.

Cable trays

Wiring in exposed areas, for example factory floors, may be run in cable trays or rectangular raceways having lids.

Cable trays are used in industrial areas where many insulated cables are run together. Individual cables can exit the tray at any point, simplifying the wiring installation and reducing the labour cost for installing new cables. Power cables may have fittings in the tray to maintain clearance between the conductors, but small control wiring is often installed without any intentional spacing between cables.

Since wires run in conduits or underground cannot dissipate heat as easily as in open air, and since adjacent circuits contribute induced currents, wiring regulations give rules to establish the current capacity (ampacity).

Special sealed fittings are used for wiring routed through potentially explosive atmospheres.

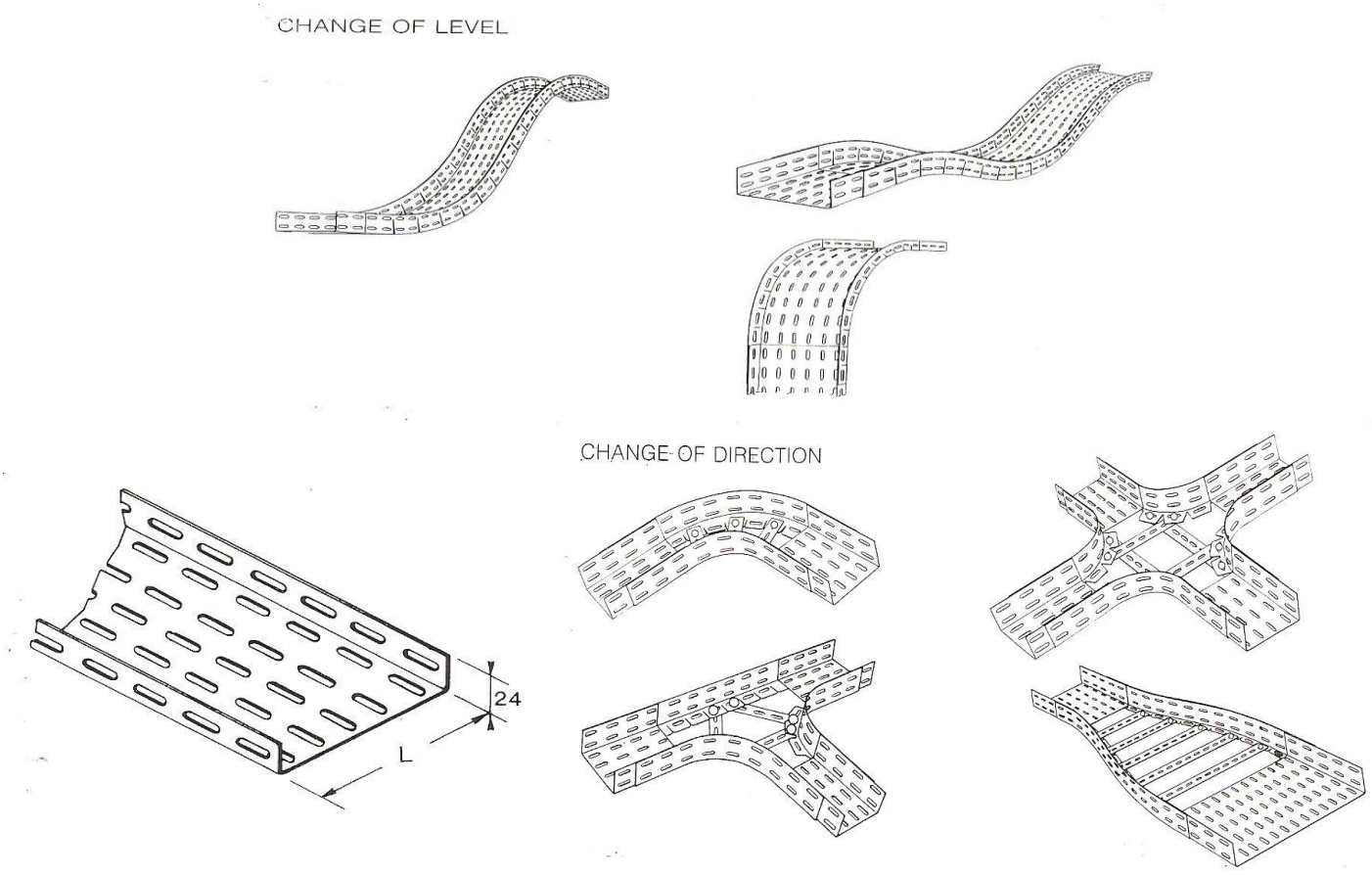


Fig.7 Cable trays.